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Assessing Participation in Community-Based Physical Activity Programs in Brazil

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Abstract

Purpose—This study aimed to develop and validate a risk prediction model to examine the characteristics that are associated with participation in community-based physical activity programs in Brazil.

Methods—We used pooled data from three surveys conducted from 2007 to 2009 in state capitals of Brazil with 6166 adults. A risk prediction model was built considering program participation as an outcome. The predictive accuracy of the model was quantified through discrimination (C statistic) and calibration (Brier score) properties. Bootstrapping methods were used to validate the predictive accuracy of the final model.

Results—The final model showed sex (women: odds ratio [OR] = 3.18, 95% confidence interval [CI] = 2.14–4.71), having less than high school degree (OR = 1.71, 95% CI = 1.16–2.53), reporting a good health (OR = 1.58, 95% CI = 1.02–2.24) or very good/excellent health (OR = 1.62, 95% CI = 1.05–2.51), having any comorbidity (OR = 1.74, 95% CI = 1.26–2.39), and perceiving the environment as safe to walk at night (OR = 1.59, 95% CI = 1.18–2.15) as predictors of participation in physical activity programs. Accuracy indices were adequate (*C* index = 0.778, Brier score = 0.031) and similar to those obtained from bootstrapping (*C* index = 0.792, Brier score = 0.030).

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Conclusions—Sociodemographic and health characteristics as well as perceptions of the environment are strong predictors of participation in community-based programs in selected cities of Brazil.

Keywords

EVIDENCE-BASED PUBLIC HEALTH; ADULTS; RISK MODELING; HEALTH PROMOTION

Physical inactivity has been described as a global pandemic (18) with major public health implications due to its impact on noncommunicable diseases. Physical inactivity accounts for as many as 5.3 million deaths per year worldwide (19). In addition, noncommunicable diseases and physical inactivity are strikingly higher in developing nations (39), primarily affecting populations of low socioeconomic status, older adults, and women (10). The rapid social and built environment changes in low- and middle-income countries are exposing these population groups to greater risks for inactivity in part due to increased reliance on motorized transportation, rapid urbanization, and low access to public infrastructure for physical activity practice (2).

Most evidence regarding physical activity promotion interventions has been derived from high-income countries (13). There is growing need for interventions that are effective and contextually relevant for promoting physical activity in the developing world, where the largest proportion of the population lives (35). Recently, examples of promising interventions for promoting physical activity have begun to emerge in Latin America. In Bogota, Colombia, the combination of closing the streets to motorized vehicles and the offering of free physical activity classes to the community have been implemented for more than a decade (30). In Brazil, medium- and large-sized cities have implemented physical activity classes and environmental changes to deliver programs to the population free of charge (20,21,27,28,31). The peer review literature has highlighted these examples as promising interventions with high potential for scaling-up and dissemination to other regions (16,17), primarily due to two reasons. First, there is a consistent positive association between participation in these programs and higher levels of physical activity (21,27,28,31,34); and second, these types of programs have been replicated in various cities from different countries (13,15,30,41), demonstrating external validity.

However, most of the evidence regarding community-based physical activity interventions is derived from cross-sectional studies (13), particularly those carried out in developing countries (27,28,31,34). In addition, limited examination of participants' characteristics has been conducted. Longitudinal data on these types of programs are rare, and randomized designs are impractical where programs have already been implemented and running for many years. Researching participant's characteristics will allow determining if these interventions are engaging high-risk groups for inactivity such as older adults, women, and people of low socioeconomic status. Hence, it is important to use approaches that will help answer this question using innovative methods as well as the best available information.

The risk prediction model (RPM) has been used in the study of chronic and infectious diseases to identify risk factors and to quantify (or rank) each factor's relative importance in predicting a specific outcome (22). These models allow researchers to rank participants or patients according to the importance of these factors and also help to identify those at highest risk for a clinical outcome (22). To the authors' knowledge, RPM has not been used to predict participation in physical activity programs. However, it holds potential for further understanding of what characteristics are the most likely to be found among participants of community-based physical activity programs. The aim of this study is to develop and validate an RPM to examine the characteristics that are associated with the participation in community-based physical activity programs in Brazil.

METHODS

Data were obtained from three previous studies conducted in the Brazilian cities of Curitiba, Vitoria, and Recife; all state capitals are located in the southern, southeast, and northeast regions of Brazil, respectively (27,28,31,36). These cities promote community-level engagement in regular physical activity through programs with common core activities, including physical activity classes in the community delivered by physical activity instructors (e.g., physical education professionals), and use parks, plazas, and community centers as locations where physical activity can be performed (27,28,31,36). Participation in these programs has been previously evaluated and shown to be consistently associated with higher levels of leisure time physical activity (LTPA) in adults (27,28,31,36). In addition, all the programs are well recognized by their communities as measured by the prevalence of adults that reported hearing about or seeing an intervention activity related to the each program (27,28,31,36).

Sample and data collection

In each city, a random-digit-dialing telephone survey was carried out with the same sampling methodology used by the Brazilian Chronic Disease Risk Factor Surveillance (37). All the surveys were conducted between 2007 and 2009 mainly as part of the Guide for Useful Interventions for Physical Activity in Brazil and Latin America (Project GUIA), an international collaboration aimed at understanding physical activity promotion in Brazil (24).

Participants were noninstitutionalized residents of the three cities (n = 5969), who had resided for at least 1 yr in the same neighborhood and were at least 18 yr old. The sampling procedure was similar in all three cities, with some differences in the stratification process due to the specific characteristics of the city and recruitment of participants. The studies used a stratified and clustered multistage sampling process and response rates were 60.5% (Curitiba), 75.2% (Vitoria), and 64.5% (Recife) (27,28,31,36). Institutional review board approvals were obtained before data collection, and participants provided written consent for participation.

Measures

Only measures that were comparable across the three data sets were included in this study. The outcome variable was defined as participation in a specific physical activity program obtained through the question “Do you participate in the program CuritibAtiva (Curitiba), or Academia da Cidade (Recife), or SOE (Vitória)?”

Covariates included sociodemographic and health characteristics and also perceptions of environment related to physical activity. Age was categorized into three categories: 18–34, 35–54, and ≥55 yr. Education was classified into three levels: less than high school, complete high school, or more than high school. Marital status was classified as single, married, or living together and other (widowed/separated/divorced). Reported morbidities (e.g., diabetes, hypertension, cardiovascular disease, and hypercholesterolemia) were summed and grouped according to absence or presence of one or more comorbidities. Perceived health was classified as “poor/ regular, good, and very good/excellent” (37). The Neighborhood Environment Walkability Scale (4) was used to obtain perceptions of safety (walking/bicycling during the day and night), traffic conditions, and presence of sidewalks, all dichotomized as yes versus no, following an approach used in other studies conducted in Brazil (9,23). Because all programs included in the present analysis rely on public open spaces, safety was also included. Previous studies have showed that safety from crime could moderate LTPA levels in Brazilian adults (25). The International Physical Activity Questionnaire long version (5) was used to obtain information on LTPA, which was categorized into three levels according to the most recent recommendations for health (none, some to 149 min·wk^{-1}, and more than 150 min·wk^{-1}) (38).

Data analysis

A descriptive analysis of the sample according to participation and nonparticipation in the physical activity programs was conducted. All comparable variables were used to build an RPM to examine participation in physical activity programs as an outcome. A strategy for risk model building proposed in the literature was followed (12). First, a logistic regression model was used to determine the set of variables that best predicted the participation in physical activity programs and odds ratios (OR) were used to describe effect sizes. The selection of variables in the final model was determined by statistical significance and subjective importance. Second, the predictive accuracy of the model was quantified by both discrimination (*C* statistic) and calibration (Brier score) statistics. The *C* statistic measures the ability of the model to separate cases from noncases; the closer it is to 1, the better the discrimination of the model. The Brier score measures the closeness between the predicted probabilities and the observed outcome; the closer the score is to 0, the better the calibration of the model. The discrimination and calibration aspects of the final model were visualized by ROC curves and calibration plots. To explore the implication of applying the prediction model in the real world, sensitivity and specificity were presented as a function of the cutoff predicted probabilities. Finally, bootstrapping method was used to validate the predictive accuracy of the final model through several sequential steps (6) as follows: 1) obtaining a random sample of same size as the original data with replacement (bootstrap sample); 2) fitting a model with the bootstrap sample in the same way as the final model was fit and constructing the predictive accuracy indices (*C* index and Brier score) from the bootstrap sample model; 3) constructing the predictive accuracy indices using the parameter estimates from the bootstrap sample model and the data from the original sample; 4) estimating the optimism by subtracting the predictive accuracy indices in step 3 from the predictive accuracy indices in step 2; 5) repeating steps 1–4, 500 times, and obtaining the average optimisms; and 6) obtaining the bias-adjusted predictive accuracy indices by subtracting the average optimisms from predictive accuracy indices of the original final model.

RESULTS

Participants and nonparticipants characteristics

Sample characteristics varied according to participation and nonparticipation in the physical activity programs (Table 1). Overall, the participants group had more women and adults 55 yr and older compared with the nonpartici-pants. Participants also showed the highest percentage of low education level and married individuals. In addition, reporting very good/ excellent health, morbidity, perception of safety to walk during the night, and meeting physical activity recommendations was more frequent in participants than that in nonparticipants.

Factors associated with participation in physical activity programs

The final multiple logistic regression model shows the variables significantly associated with participation in physical activity programs (Table 2). The model shows sex (women: OR = 3.18, 95% confidence interval [CI] = 2.14–4.71), having less than a high school degree (OR = 1.71, 95% CI = 1.16–2.53), reporting good health (OR = 1.58, 95% CI = 1.02–2.24) or very good/excellent health (OR = 1.62, 95% CI = 1.05–2.51), having any comorbidity (OR = 1.74, 95% CI = 1.26–2.39), and perceiving the environment as safe to walk at night (OR = 1.59, 95% CI = 1.18–2.15) as predictors of participation in physical activity programs.

RPM and its validation

The prediction model has the form depicted in Figure 1.

The *C* index for the prediction model is 0.792, and the Brier score is 0.030 (Fig. 1), indicating a good ability of the model to separate cases from noncases and a moderate calibration of the model. This is interpreted as follows: from two subjects randomly selected, one of those who participates in physical activity programs and another who does not participate, the probability that the subject who participates has a higher predictive score than the subject who does not is 79%. The bias-adjusted predictive accuracy indices from the bootstrapping method are similar to those obtained from the final model (*C* index = 0.778, Brier score = 0.031), indicating the overfitting problem in the prediction model istrivial. The calibration plot shows that predicted probabilities slightly overestimate the true probabilities in the upper values of predictions. For example, when the true probability is 10%, the model predicted probability is around 12%–13%, whereas for a true probability of 20%, the model predicted probability is ~23%–24%.

Sensitivity and specificity analyses (Fig. 2) show that when a predicted probability of 0.179 is used as a cutoff to similar population, approximately 91% of participants would be missed whereas 98% of nonparticipants would be correctly identified. When a predicted probability of 0.051 is used as cutoff, approximately 45% of participants would be missed and 83% of the nonparticipants would be identified. However, at a probability of 0.035%, roughly 70% of participants and nonparticipants would be correctly identified. Hence, when applying this model to similar populations, the model would correctly classify seven out of ten subjects in the sample (Fig. 3).

DISCUSSION

RPM has rarely been used in physical activity research. To the authors' knowledge, this is the first study in which RPM has been used to examine participation in community-based physical activity programs. On the basis of robust models, this study showed that sociodemographic and health characteristics as well as perceptions of the environment are strong predictors of participation in physical activity programs in selected cities of Brazil.

The discrimination ability of the prediction model emerging from this study is much stronger than most population-based RPM (*C* index 0.778). For example, the Gail model for breast cancer risk prediction reported a *C* index of 0.65 (29), and the Colditz model reported a *C* index 0.68 (33). Some authors believe that an RPM with a *C* index of 0.8 or above has clinical value (12). In addition, the decomposition of Brier score into bias and variation components indicates that only part of Brier score is relevant to the calibration aspect of RPM. Despite all these caveats about Brier score, it is widely reported in the literature as a predictive index to quantify the difference between the observed and predicted outcomes. Although there is no consensus about importance of specific value for Brier score, 0.03 is close to 0. These results demonstrate that when RPM is applied to explore which factors could predict participation in physical activity programs, the resulting indices present high quality as compared with the traditional applications of this method.

This study also found that reporting any comorbidity was one of the predictors of participation; this could indicate that people who are already aware of any health limitation are using the program as an option to engage in health promoting behaviors such as physical activity, which is consistent with previous findings (1,21). This result could also reflect the link between these programs and the primary health care system in Brazil. In fact, all the examined programs are coordinated or directly linked to local health departments (20,21,27,28) and are used as prevention and control strategies for the most common noncommunicable diseases (e.g., obesity, hypertension, diabetes, and cardiovascular diseases). As part of these strategies, the population seeking health services at the local level is usually referred to attend such programs (21,28,31). These characteristics highlight the potential that community-based physical activity programs have as a prevention strategy in primary care services.

An important predictor of participation was perception of safety, which is consistent with the reported literature and with findings from other studies on community-based physical activity programs in Latin America (21,30) and also with the evidence on the use of public open spaces such as parks and plazas (7,26). Because the programs examined in this study make use of open public spaces, which are accessible to all the population, it is important to work toward improving the perception of safety from crime. Implementing measures such as public lighting or having park rangers or police officers nearby can increase the perception of safety by program users. Our results indicate that similar programs could improve their rates of participation if safer and protected environments are provided.

This study used the “the best available information” to explore the implementation of community-based programs in Brazil. This concern is in accordance with recently published reports (40) and articles (18) that have called up to researchers to prioritize the evaluation of community-wide, multicomponent approaches aimed at controlling noncommunicable diseases. Although a positive association has been found between participation in such programs and increased levels of LTPA (21,27,28,31), evidence on their effectiveness is conflicting. Systematic reviews that examined this issue found different results (1,31), largely due to the use of weak study designs (e.g., cross-sectional studies). On the other hand, such programs have been recently widely implemented, particularly in Latin America (20,30), emphasizing the need for further examination. This approach is in accordance with the need for identifying best practices to address complex public health and on the use of “best evidence available” (3,32).

This study has several limitations. The data on participation in physical activity programs were derived from cross-sectional studies, preventing any conclusion on causality. The measure used to determine participation in community-based programs used a single question representing one point in time. Future studies should include information on program's adherence and dropouts. The variables included as potential predictors of participation were only the measures comparable across all sites and other factors potentially correlated with participation were not considered in the final model (e.g., income, access to the programs facilities, and working hours). Therefore, the prediction model may not have included the most relevant variables, but a set of independent predictors of participation on community-based physical activity programs that were readily available. All measures were self-reported, and although some reported characteristics are less likely to be affected by recall biases (e.g., sex, and education), the outcome variable could be overestimated. Despite the inherent limitations, the study has many strengths. A large sample of adults was analyzed, preventing any power concerns in the analyses. Despite the large sample size, only a few cases are allocated in the reference category, for instance, men, when exploring the relationship with sex, thus preventing further sex-specific analyses. We found that *C* indexes were 0.81 for men and 0.76 for women, respectively. This indicates just a slightly better discrimination ability was present for men compared with women. However, all the predictors were the same regardless of sex, increasing the generalizability of the model. Also, the RPM included data from three different regions within Brazil increasing the generalizability to the region. The outcome and predictor measures and the methods used in all three data sets included in the analyses are identical, preventing issues related to measurement errors and biases.

The findings illustrate significant practical implications, particularly for the scale-up of similar programs in other communities from Latin America. Previous research from Brazil and elsewhere shows the highest risk of inactivity among women and low-income groups (2,10,21). Population-based physical activity programs have the potential of reaching large segments of the population and studies such as this one will help understand the characteristics of program users to maximize their reach and effectiveness. For instance, this study showed that lower levels of education and sex (women) were important predictors of participation, which indicates that programs with similar characteristics could expect to engage these groups in their activities. Although data available from large surveys and also from the Brazilian risk factors surveillance system show that sex (male), education level, and income are positively related with LTPA (8,11), we found these characteristics are inversely associated with participation in community programs. We hypothesize that these programs provide access for those who cannot afford or even do not have access to private physical activity facilities and services (e.g., classes of physical activity). Previous studies showing that access to private facilities (14) and neighborhood income (28) are associated with LTPA in Brazilian adults partially support this hypothesis. A practical implication is notable in the national physical activity program that is currently under implementation in 4000 cities in Brazil and is partially based in the experiences of the programs examined in this study (20). In addition, as in most of the countries in the world, particularly those of low and middle income, these population groups are those at higher risk of physically inactivity (2,10), and such programs could act as an important social policy for local governments trying to reduce health disparities. This study used an innovative approach to explore which factors predict participation in community-based physical activity program. The use of RPM could help to understand the factors affecting participation in such programs when ideal research designs (e.g., randomized trials) are not feasible.

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$$\mathrm{Logit}[\mathrm{Prob}(\mathrm{Participation}=1)]=1.096(X1=2)-0.273(X2=2)-0.5386(X2=3)-0.465(X3=1)+0.382(X4=2)+0.017(X4=3)+0.418(X5=2)+0.486(X5=3)+0.551(X6=1)$$

Where: X1=Gender; X2=Education; X3=Dangerous to walk at night; X4=Marital Status; X5=Perceived Health; X6=Any Morbidity

FIGURE 1.
RPM form.

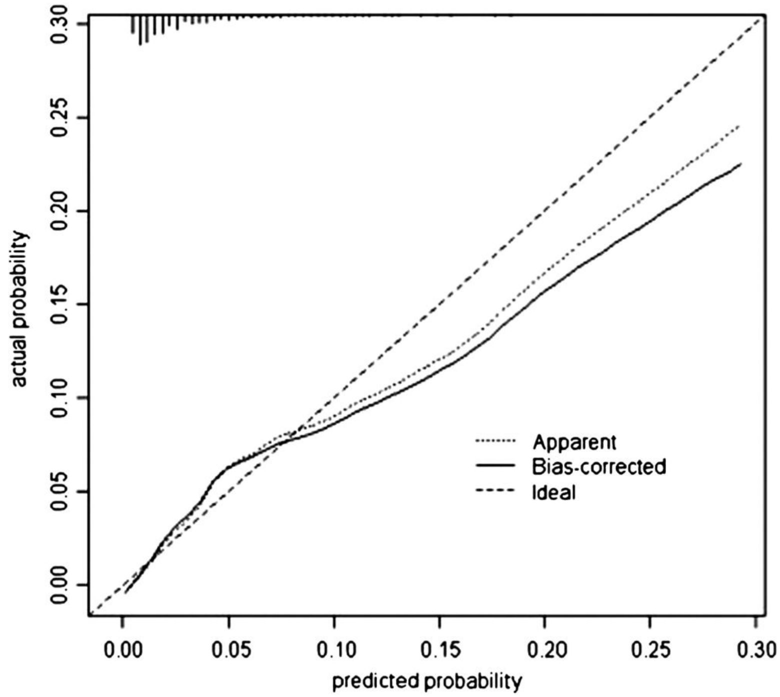

FIGURE 2.

Participation in community-based physical activity programs prediction model calibration plot (predicted probabilities from the risk model are identified in the dotted line; bootstrap bias-corrected probabilities are identified in the solid line).

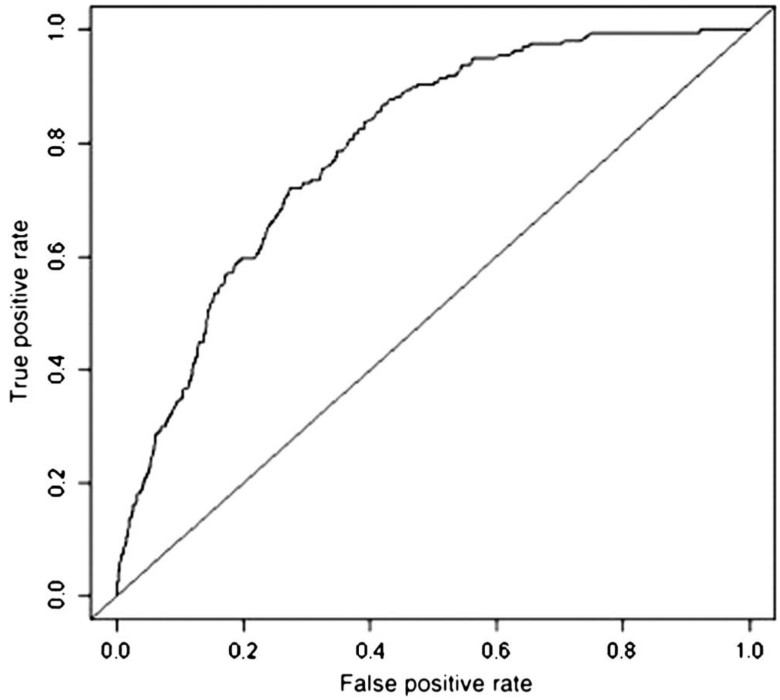

FIGURE 3.

3—Receiver operating characteristic (ROC) curve for participation in community-based physical activity programs prediction model.

TABLE 1

Sociodemographic, health, and physical activity characteristics of participants and nonparticipants in community-based physical activity programs in Brazil.

		Nonparticipants		Participants		
Variables	**Categories**	***n***	**Pct.**	***n***	**Pct.**	P^a
Sex	Men	2234	37.4	42	21.3	<0.001
	Women	3735	62.6	155	78.7	
Age	≤34	1885	31.6	40	20.3	0.001
	35–54	2340	39.2	80	40.6	
	≥55	1744	29.2	77	39.1	
Education	<High	1720	29.0	74	37.6	0.031
	High school	2077	35.1	64	32.5	
	>High school	2124	35.9	59	29.9	
Marital status	Widow/divorced	1046	17.5	39	19.8	0.016
	Married	3076	51.5	116	58.9	
	Single	1847	30.9	42	21.3	
Perceived health	Poor/regular	1879	31.6	44	22.3	0.017
	Good	2468	41.4	88	44.7	
	Very good/excellent	1608	27.0	65	33.0	
Any morbidity	No	3888	65.5	103	52.3	<0.001
	Yes	2046	34.5	94	47.7	
Dangerous to walk at night	Yes	3982	67.7	110	56.1	0.001
	No	1903	32.3	86	43.9	

[a] Heterogeneity chi-square.

TABLE 2

Multiple logistic regression analysis on the factors predicting participation in community-based physical activity programs in Brazil.

Variables	Categories	Pct.[a]	*B*	SE	Wald	*P*	OR[b]	95% CI
Sex	Men	1.8	Ref	—	—	—	—	—
	Women	4.0	1.158	0.291	33.336	<0.001	3.18	2.14–4.71
Education	>High school	2.7	Ref	—	—	—	—	—
	High school	3.0	0.266	0.191	1.941	0.164	1.30	0.90–1.90
	<High school	4.1	0.539	0.198	7.364	0.007	1.71	1.16–2.53
Marital status	Single	2.2	Ref					
	Married	3.6	0.382	0.192	1.990	0.164	1.46	0.97–2.13
	Widow/divorced	3.6	0.017	0.244	0.070	0.943	1.01	0.63–1.64
Perceived health	Poor/regular	2.3	Ref	—	—	—	—	—
	Good	3.4	0.418	0.200	4.372	0.036	1.58	1.02–2.24
	Very good/excellent	3.9	0.486	0.224	4.723	0.029	1.62	1.05–2.51
Any morbidity	No	2.6	Ref	—	—	—	—	—
	Yes	4.4	0.551	0.162	11.534	<0.001	1.74	1.26–2.39
Dangerous to walk at night	Yes	2.7	Ref	—	—	—	—	—
	No	4.3	0.465	0.155	9.027	0.002	1.59	1.18–2.15

[a] Rates of participation in the programs.

[b] Odds ratio.